LABORATORY EVALUATION OF
LEADX ABRASIVE ADDITIVE

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INTRODUCTION

In accordance with Proactive Environmental Research & Development Inc. (Proactive Environmental) Purchase Order No. KI-8296 dated August 2, 1996, KTA-Tator, Inc. (KTA) has completed the evaluation of LEADX abrasive additive. Lead-based coatings were removed from prepared steel test panels by abrasive blast cleaning using proportional mixtures of common abrasives and the abrasive additive. The ability of the abrasive additive to reduce the concentration of leachable lead present in the abrasive blast cleaning waste was evaluated, as well as the ability of the abrasive additive to reduce airborne concentrations of lead during lead-based paint removal operations. KTA also conducted testing to determine if the abrasive additive has a detrimental effect on the performance of coatings through physical testing of primer systems applied to test panels abrasive blast cleaned with and without the LEADX / abrasive mixtures.

SUMMARY

The results of the laboratory investigation revealed that LEADX abrasive additive was effective in reducing leachable lead concentrations of abrasive blast cleaning waste generated during removal of lead containing paint. The abrasive additive rendered the paint removal debris, generated during this evaluation, below the hazardous threshold according to 40 CFR 261.24 “Toxicity Characteristic”. Federal regulation 40 CFR 261.24 “Toxicity Characteristic” requires that abrasive blast cleaning waste containing more than 5 parts per million leachable lead when tested in accordance with EPA Method 1311 “Toxicity Characteristic Leaching Procedure (TCLP)” be classified as hazardous (D008). Based upon the testing, performed in this study, none of the analyses resulted in a leachable level above the 5.0 ppm threshold when abrasives were treated with LEADX prior to use.

The long term effectiveness of the abrasive additive (or the stability of the waste) was also determined using EPA Method 1320 “Multiple Extraction Procedures (MEP)”. This test simulates 100 year stability of leachable lead. The results of the MEP testing were all below the detection limit of 1.0 part per million.

The abrasive additive did not adversely affect the performance of four common coating systems. No significant differences in coating adhesion, degree of rusting, or degree of blistering were found between steel panels blast cleaned with the abrasive / LEADX mixtures and the untreated abrasives.

The LEADX abrasive additive however, did not appear to reduce airborne concentrations of lead during abrasive blast cleaning operations.

LABORATORY INVESTIGATION

Initial Test Panel Preparation

Randomly selected carbon steel test panels were used for the abrasive additive evaluation. The size of the panels was 24 inches by 24 inches by 3/16 inch thick. A total of 15 randomly numbered panels were used. All steel panels used for the substrate material were purchased from the same supplier and chosen from the same mill rolling to ensure that the characteristics of the steel were consistent. Two coats of Puritan Paint & Oil Company's lead containing alkyd primer (60% by weight lead content) were applied to the panels in accordance with the manufacturer's instructions. In order to provide consistent results, the paint was applied using a semi-automatic, hydraulically-operated spray arm equipped with a DeVilbiss Type AGB automatic conventional (air) spray gun. Prior to painting, the panels were blast cleaned using a coal slag abrasive. Resulting average dry film thickness of the lead-based coatings are shown in the following table.

Panel Number	Primer Dry Film Thickness (mils)	System Dry Film Thickness (mils)
3	3.38	5.31
6	3.17	5.23
10	3.21	5.20
11	3.30	4.95
12	3.61	4.97
38	3.78	5.10
39	3.73	4.96
40	3.70	5.20
41	3.62	5.46
47	3.78	4.92
48	3.53	4.98
49	3.79	4.96
50	3.86	4.91
56	4.10	5.23
57	3.62	4.95

Coatings on all panels were cured (aged) for 14 days in a forced convection oven at approximately 110^{o}F.

Abrasive Blast Cleaning

All abrasive blast cleaning was performed at KTA's facility in Pittsburgh, Pennsylvania using a clean, enclosed, illuminated 12' x 8' x 8' walk-in blast room. The blast room was ventilated using a 5,800 CFM dust collector. The blast cleaning equipment consisted of a production Schmidt 600 pound gravity feed abrasive blast pot, a 15 foot length of reinforced air / abrasive hose and a No. 4 (1/4 inch orifice) venturi blast nozzle.

Abrasive media used during this testing program consisted of silica sand and coal slag abrasives with varying amounts of LEADX abrasive additive (dictated by Proactive Environmental) as shown in the following table:

Abrasive Type	**Amount of LEADX Abrasive Additive (% by weight)**
Silica Sand	0%
Silica Sand	25%
Coal Slag	0%
Coal Slag	15%
Coal Slag	25%

Environmental conditions (air temperature, steel surface temperature, relative humidity, dew point temperature) within the blast room were documented for each abrasive trial. Measurements are shown in Appendix 1. - "Blast Cleaning Inspection Reports". Steel panels were abrasive blast cleaned in accordance with the Steel Structures Painting Council Surface Preparation (SSPC) Standard No. 10 "Near-White Metal Blast Cleaning" (SP-10).

In order to eliminate the possibility of cross contamination between abrasive trials, all equipment and facilities were cleaned between trials. At the completion of each abrasive trial, the abrasive hopper, blast hose and nozzle were cleaned by exhausting clean, dry compressed air through the system for approximately one minute with the ventilation system in operation. The blast hose was rinsed with water and dried with clean, dry compressed air. Two blast hoses were used and alternated to allow thorough drying prior to use. The walls, floor, and ceiling of the blast room were thoroughly vacuumed and wiped with clean moist rags between abrasive blast cleaning trials. The blast helmet, coveralls, boots and gloves were decontaminated. An industrial hygiene technician witnessed blast room cleaning procedures and inspected the blast room after each cleaning procedure to help ensure prevention of sample cross contamination.

Cleaning and Consumption Rates; pH

During abrasive blast cleaning trials, the abrasive cleaning rate and consumption rate were documented for each abrasive and abrasive / additive mixture. This was performed to determine if the LEADX additive affects abrasive performance. Cleaning rate is a measure of the abrasive productivity and is the amount of surface area prepared per unit of time. Consumption rate is the amount of abrasive required to prepare square footage of substrate. The pH of the surface was also measured using pH indicator paper to determine the effect of LEADX additive on surface acidity / alkalinity. A summary of abrasive blast cleaning characteristics is shown in the following table.

Abrasive Type	Amount of LEADX (% by weight)	Cleaning Rate (FT^2 / minute)	Consumption Rate (Lb. / FT^2)	pH of Cleaned Surface
Silica Sand	0%	2.2	6.0	7
Silica Sand	25%	3.4	5.7	7
Coal Slag	0%	1.6	5.6	7
Coal Slag	15%	1.6	9.3	7.5
Coal Slag	25%	1.4	10.2	7

Leachable Lead Content (TCLP)

At the completion of each abrasive trial, a representative 100 pound quantity of abrasive debris with paint chips was collected from the blast room floor and riffled to ensure a homogenous mixture. Samples were taken from the riffled homogenous mixture of blasting debris for hazardous material classification by EPA Method 1311 "Toxicity Characteristic Leaching Procedure (TCLP). Briefly, this method involves tumbling a 100 gram sample in glacial acetic acid solution for eighteen hours, filtering, and analyzing the liquid by atomic absorption spectroscopy. The limit of detection for the method is 0.5 parts per million (ppm) leachable lead. The results of this testing are as follows:

Abrasive	Amount of LEADX (% by weight)	Leachable Lead (ppm)
Silica Sand	0%	70.0
Silica Sand	25%	0.7
Coal Slag	0%	11.0
Coal Slag	15%	1.3
Coal Slag	25%	0.9

At the request of Proactive Environmental, TCLP tests were performed on five additional abrasive debris samples resulting from abrasive blast cleaning using the coal slag abrasive media with 15% LEADX additive. The results are shown below.

Abrasive	**Amount of LEADX (% by weight)**	**Leachable Lead (ppm)**
Coal Slag	15%	0.6
Coal Slag	15%	0.6
Coal Slag	15%	1.1
Coal Slag	15%	1.2
Coal Slag	15%	1.6

Leachable Lead Content (MEP)

One sample of debris resulting from abrasive blast cleaning of lead-based paint coated panels using a coal slag abrasive with 15% LEADX additive was tested in accordance with EPA Method 1320 “Multiple Extraction Procedures”. This test consisted of analyzing the sample in accordance with EPA Method 1310, then repeating a portion of this test to complete ten cycles in accordance with EPA Method 1320. Briefly, the first cycle involves tumbling a 100 gram sample in 60/40 sulfuric/nitric acid solution for 24 hours. During this time the pH is monitored and adjusted at time intervals starting at 15 minutes and extending to longer intervals as the testing continues. The pH of the solution during cycles 2 to 10 was only tested at the beginning and end of each extraction procedure to determine if there was a change in pH. The same sample of debris was weighed and extracted each day. After each 24 hour extraction, the sample was filtered and a portion of the solution retained for analysis by atomic absorption spectroscopy. Although several samples were tested, all of the results were below the EPA Method 1320 detection limit of 1.0 part per million leachable lead.

Airborne Lead Concentrations

Proactive Environmental was interested in determining the effect of the abrasive additive on airborne concentrations of lead during abrasive blast cleaning operations. To this end, industrial hygiene monitoring was conducted to determine total airborne lead concentrations. Prior to each abrasive trial, air sampling pumps were calibrated using a Gilian Gilibrator-2 primary calibration precision flow bubble meter equipped with a standard flow cell (20cc-6 lpm). Calibration was conducted through representative filter media. Actual flow rates for each pump were documented on the attached sampling pump calibration reports (see Appendix 2). Verification of the flow rates was conducted at the completion of each abrasive trial. Post trial pump flow rates are also presented in Appendix 2. Filter media were positioned in sample holders located at three areas within the blast room. The areas include the make-up air end of the blast room, the operator's area, and the exhaust (ventilation) end of the blast room. Sample holders were positioned 12 inches from the side walls, at breathing zone height (5 to 6 feet). One additional sampling pump and filter was positioned on the operator with the filter located in the breathing zone (a hemisphere 6 to 9 inches from the operator's nose and mouth, forward of the shoulders) in a downward direction, outside of respiratory protection. Elemental samples were collected in each of the three areas in the blast room and within the breathing zone of the operator using sampling pumps equipped with 37 mm, 0.8 micron pore size mixed cellulose ester membrane filter media. Sampling was conducted at a flow rate of 2.0 liters per minute. Analysis for elemental lead was performed by Corning Industrial Laboratories in Youngstown, Ohio using NIOSH Method 7082 (flame atomic absorption spectroscopy). Laboratory reports are attached in Appendix 3. The following table illustrates the average airborne lead concentrations and the corresponding ranges.

Abrasive	**Amount of LEADX (% by weight)**	**Airborne Lead Concentration Average ($\mu g/m^3$)**	**Airborne Lead Concentration Range ($\mu g/m^3$)**
Silica Sand	0%	3,062	353 to 7,800
Silica Sand	25%	4,900	644 to 10,000
Coal Slag	0%	3,162	735 to 5,783
Coal Slag	15%	5,304	2,822 to 8,000
Coal Slag	25%	3,071	923 to 4,885

Coating Performance Testing

In order to determine whether LEADX abrasive additive adversely affects coating performance, commonly used industrial maintenance primers were applied steel panels prepared during the abrasive trials and subjected to physical testing. The following primers were applied to the panels in accordance with the manufacturer's instructions.

Polyamide Epoxy
Coal Tar Epoxy
Inorganic Zinc (water-based)
Organic Zinc (epoxy-based)

In order to provide consistent results, the paint was applied using a semi-automatic, hydraulically operated spray arm equipped with a DeVilbiss Type AGB automatic conventional (air) spray gun. After curing the panels were dry saw cut into suitable sizes for testing (4 inch by 6 inch) and the exposed edges treated. Physical testing of coating integrity consisted of measuring adhesion in accordance with ASTM D3359 "Standard Test Method for Measuring Adhesion by Tape Test"; tap water immersion in accordance with procedures outlined in ASTM D1308 "Effect of Household Chemicals on Clear and Pigmented Organic Finishes", for 1000 hours (six weeks); and ten freeze / thaw / immersion cycles. Although no coating performance testing can predict the performance of coatings in all environments, the testing performed as part of this evaluation would likely reveal if any contamination detrimental to coating performance (present in the abrasive additive) was deposited onto the steel surfaces, compared to surfaces cleaned with untreated abrasives.

Adhesion

Adhesion was rated in accordance with ASTM D3359. Depending on the dry film thickness of the system, the adhesion was either rated in accordance with Method A or Method B. Method A was used for panels which had coating thickness in excess of 5 mils, while Method B was used on coatings which were less than 5 mils. In each case, the adhesion was rated on a scale of 0 to 5, with 5 representing no adhesion loss, and 0 representing either removal of greater than 65% of the cut surface (Method B) or removal of paint beyond the cut area (Method A). Ratings of 0 and 1 represent poor adhesion, 2 and 3 represent fair adhesion, and ratings of 4 and 5 represent good adhesion. Three adhesion tests were conducted for each coating and abrasive type. Average adhesion results are shown in the following table:

Abrasive	Amount of LEADX (% by weight)	Epoxy	Coal Tar Epoxy	Inorganic Zinc	Organic Zinc
Silica Sand	0%	5B	2A	2B	4B
Silica Sand	25%	4B	2A	2B	5B
Coal Slag	0%	4B	3A	0B	4B
Coal Slag	15%	4B	2A	3B	5B
Coal Slag	25%	4B	2A	2B	4B

Freeze / Thaw / Immersion Cycles

The freeze / thaw / immersion cycles consisted of 7-1/2 hours at 140^{o}F, 1/2 hour of tap water immersion at room temperature, and 16 hours in a freezer maintained at approximately 0^{o}F. After ten cycles of this exposure, the adhesion was evaluated as described above. The results are shown below:

Abrasive	Amount of LEADX (% by weight)	Epoxy	Coal Tar Epoxy	Inorganic Zinc	Organic Zinc
Silica Sand	0%	4B	2A	1B	4B
Silica Sand	25%	4B	2A	0B	5B
Coal Slag	0%	4B	2A	0B	4B
Coal Slag	15%	4B	2A	2B	5B
Coal Slag	25%	4B	2A	3B	4B

Tap Water Immersion

Several panels were placed in tap water which was maintained at room temperature (70^{o}F). The panels were exposed for a duration of 1000 hours. After removal from the water, the panels were rated for rusting and blistering. The rusting was rated in accordance with ASTM D610 “Evaluating Degree of Rusting on Painted Steel Surfaces“. This method rates rusting on a scale of 0 to 10, with 10 representing no rusting and 0 representing rusting of more than 50% of the exposed area. Blistering was rated in accordance with ASTM D714 “Evaluating Degree of Blistering of Paints“. This method rates blistering by both size and frequency. Size was rated on a scale of 0 to 10, with 10 representing no blistering. Frequency is rated as either dense (D), medium dense (MD), medium (M), or few (F). The results of this testing follow:

Abrasive	Amount of LEADX (% by weight)	Epoxy		Coal Tar Epoxy		Inorganic Zinc		Organic Zinc	
		Rust	Blisters	Rust	Blisters	Rust	Blisters	Rust	Blisters
		9	10	10	10	0*	10	10	10
Silica Sand	0%	9	10	10	10	0*	10	10	10
		9	10	10	10	0*	10	10	10
		10	10	10	10	0*	10	10	10
Silica Sand	25%	10	6F	10	10	0*	10	10	10
		10	10	10	10	0*	10	10	10
		10	8F	9	10	0*	10	10	6F
Coal Slag	0%	10	6F	9	10	0*	10	10	10
		10	10	9	10	0*	10	10	10
		10	10	10	10	0*	10	10	6F
Coal Slag	15%	10	8F	10	10	0*	10	10	10
		10	10	10	10	0*	10	10	6F
		10	6F	10	10	0*	10	10	10
Coal Slag	25%	10	10	10	10	0*	10	10	10
		10	10	10	10	0*	10	10	10

* Panels were covered with white zinc oxide, but no red rust was visible

DISCUSSION

The laboratory results indicate that LEADX abrasive additive reduces the leachable lead content in lead-based paint surface preparation waste. Leachable lead levels from abrasive waste, generated with abrasives treated with LEADX prior to abrasive blast cleaning, were reduced a minimum of 85% and a maximum of 99%, compared to leachable lead content resulting from waste generated using untreated abrasives. Further, the results of EPA Method 1320 “Multiple Extraction Procedures” revealed leachable lead levels below the EPA threshold of 5.0 ppm.

No significant differences were found in the cleaning or consumption rates of the abrasive materials due to the inclusion of the abrasive additive. In fact, the cleaning rate was approximately the same for the treated (15%) and untreated coal slag abrasive, while coal slag with 25% LEADX by weight decreased the cleaning rate by 13%.

Similarly, no significant differences were found between the performance of four industrial coating systems applied to steel test panels prepared using the treated and untreated abrasive materials. No differences in coating adhesion (prior to or after ten freeze / thaw / immersion cycles) were found attributable to the abrasive additive. Additionally, there was no increase in the degree of rusting of coated steel panels prepared with treated and untreated abrasives subjected to 1000 hours of tap water immersion. Blistering was observed (rating of 6F) on two of the three specimens cleaned with coal slag (15% additive) and coated with organic zinc. However, one of three specimens cleaned with untreated coal slag and coated with the same system revealed similar blistering. Therefore the blistering data is deemed inconclusive. However, based on the performance of the other coating systems and levels of additive, it is unlikely that the blistering is a result of the additive. Further testing may be required to further assess this characteristic.

CONCLUSION

In conclusion, the results of the laboratory investigation revealed that LEADX abrasive additive was effective in reducing leachable lead concentrations of abrasive blast cleaning waste generated during removal of lead containing paint. The abrasive additive rendered the paint removal debris, generated during this evaluation, below the hazardous threshold according to 40 CFR 261.24 “Toxicity Characteristic”. Federal regulation 40 CFR 261.24 “Toxicity Characteristic” requires that abrasive blast cleaning waste containing more than 5 parts per million leachable lead when tested in accordance with EPA Method 1311 “Toxicity Characteristic Leaching Procedure (TCLP)” be classified as hazardous (D008). Based upon the testing, performed in this study, none of the analyses resulted in a leachable level above the 5.0 ppm threshold when abrasives were treated with LEADX prior to use.

The long term effectiveness of the abrasive additive (or the stability of the waste) was also determined using EPA Method 1320 “Multiple Extraction Procedures (MEP)”. This test simulates 100 year stability of leachable lead. The results of the MEP testing were all below the detection limit of 1.0 part per million.

The abrasive additive did not adversely affect the performance of four common coating systems. No significant differences in coating adhesion, degree of rusting, or degree of blistering were found between steel panels blast cleaned with the abrasive / LEADX mixtures and the untreated abrasives.

The LEADX abrasive additive however, did not appear to reduce airborne concentrations of lead during abrasive blast cleaning operations.